CLAIMS:

1. A method of determining the time of flight of a signal transmitted between a transmitter and a receiver, said method comprising the steps of:

transmitting a first signal comprising at least one characteristic waveform feature;

transmitting a second signal comprising at least one characteristic waveform feature and a waveform modification introduced at a predetermined point in time of the duration of the second signal;

receiving said first and second transmitted signals;

determining a point of diversion between corresponding characteristic waveform features of the first and second received signals comprising super positioning said first and second received signals such that said point of diversion corresponds to an arrival time of the introduced waveform feature modification at the receiver.

2. The method of claim 1 wherein the step of determining a point of diversion further comprises:

calculating the difference between a value of the first received signal and a corresponding value of the second received signal at each point of occurrence of a characteristic waveform feature within the first received signal;

designating the point of diversion as the first point of occurrence at which the calculated difference is greater than the value of the second received signal.

3. The method of claim 2 further comprising the step of:

calculating the difference between the time of the point of diversion and the time of transmission of the introduced waveform feature modification.

4. The method of claim 2 further comprising the steps of:

measuring a time relationship between a nominated characteristic waveform feature and the point of diversion and;

calculating the difference between the time of reception, based on the measured time relationship, and the time of transmission of the nominated characteristic waveform feature.

5. The method of claim 4 wherein the nominated characteristic waveform feature is a feature of a first unmodified signal and the method further comprises the steps of:

transmitting a plurality of subsequent first unmodified signals and;

determining the time of flight of the plurality of subsequent first unmodified signals by calculating the difference between the time of reception, based on the measured time relationship, and the time of transmission of the nominated characteristic waveform feature of each respective one of the plurality of subsequent first unmodified signals.

6. The method of claim 1, 2, 3 or 4 further comprising the step of:

repeating the steps of transmitting and receiving such that successive first and second signals are super positioned at the step of determining.

7. The method of any one of the preceding claims wherein the characteristic waveform feature of a signal is one of:

a) a peak;

b) a combination of peaks;

c) a zero-crossing;

d) a combination of zero-crossings.

8. The method of any one of the preceding claims wherein the waveform modification is introduced near the start of a signal.

9. The method of claim 8 wherein the waveform modification is introduced at one of the third, fourth or fifth waveform peak after the onset of a signal.

10. The method of any one of the preceding claims wherein the waveform modification comprises a phase inversion.

11. The method of any one of the preceding claims wherein the transmitted and received signals are ultrasonic signals.

12. The method of claim 11 wherein the ultrasonic signals are provided by transducers driven at resonant frequencies in a frequency range of about 60kHz to about 90kHz.

13. Apparatus adapted to determine the time of flight of a signal transmitted between a transmitter and a receiver, said apparatus comprising:

processor means adapted to operate in accordance with a predetermined instruction set,

said apparatus, in conjunction with said instruction set, being adapted to perform the method of any one of claims 1 to 12.

14. A method of determining the time of flight of a signal transmitted between a transmitter and a receiver, said method comprising the steps of:

transmitting a first and a second signal, where both signals comprise at least one characteristic waveform feature and the second signal further comprises a waveform modification introduced at a predetermined point in time of the duration of the second signal;

receiving said first and second transmitted signals;

scanning through said received signals in time to determine a point of diversion between corresponding characteristic waveform features of the first and second received signals, wherein said point of diversion corresponds to a time of reception of the introduced waveform feature modification at the receiver.

15. The method of claim 14 further comprising the steps of:

for each characteristic waveform feature of the first received signal calculating the difference between a value of the first received signal and a corresponding value of the second received signal;

designating the first point of occurrence at which the calculated difference is greater than the value of the second received signal as a point of diversion.

16. The method of claim 15 further comprising the step of:

calculating the difference between the time of the point of diversion and the time of transmission of the introduced waveform feature modification;

17. The method of claim 15 further comprising the step of:

measuring a time relationship between a nominated characteristic waveform feature and the point of diversion and calculating the difference between the time of reception, based on the measured time relationship, and the time of transmission of the nominated characteristic waveform feature.

18. The method of claim 17 wherein for a plurality of subsequent transmitted first unmodified signals, the time of flight is determined by:

calculating the difference between the time of reception, based on the measured time relationship, and the time of transmission of the nominated characteristic waveform feature of respective subsequent first unmodified signals without reference to the point of diversion.

19. The method of claim 18 wherein the nominated characteristic waveform feature of the respective subsequent signals is tracked to allow for variations in arrival time due to physical changes in the transport medium between the transmitter and receiver.

20. Apparatus adapted to determine the time of flight of a signal transmitted between a transmitter and a receiver, said apparatus comprising:

processor means adapted to operate in accordance with a predetermined instruction set,

said apparatus, in conjunction with said instruction set, being adapted to perform the method of any one of claims 14 to 19.

21. The method of any one of claims 1, 2, 7 to 12, 14 or 15 further comprising the steps of:

selecting a characteristic waveform feature of a first signal in accordance with predetermined selection criteria based on the point of diversion;

transmitting and receiving a plurality of first signals;

detecting zero-crossings of the received plurality of first signals which indicate the presence of the selected characteristic waveform feature in each of the received plurality of first signals;

estimating a position of the selected characteristic waveform feature of the received plurality of first signals in accordance with predetermined estimation criteria based on the detected zero-crossings to provide a position estimation value;

processing the position estimation value to determine a corresponding estimation time;

calculating the time of arrival of the selected characteristic waveform feature of at least one of the received plurality of first signals by adding a predetermined delay time to the estimation time.

22. The method of claim 21 wherein the predetermined selection criteria comprise one of:

a) adding a predefined delay to the time of the point of diversion;

b) subtracting a predefined delay from the time of the point of diversion.

23. The method of claim 21 or 22 wherein the predetermined estimation criteria comprise:

a) measuring the time of zero-crossings adjacent the selected characteristic waveform feature and;

b) averaging the measured time of zero-crossings.

24. Apparatus adapted to determine the time of flight of a signal transmitted between a transmitter and a receiver, said apparatus comprising:

processor means adapted to operate in accordance with a predetermined instruction set,

said apparatus, in conjunction with said instruction set, being adapted to perform the method of any one of claims 21 to 23 wherein said apparatus comprises:

signal transducing means for transmitting and receiving a plurality of first signals;

waveform feature selection means operatively connected to the signal transducing means and the processor means for selecting a characteristic waveform feature of a first signal in accordance with predetermined selection criteria based on the point of diversion;

zero-crossing detection means operatively connected to transducing means and the processor means for detecting zero-crossings of the received plurality of first signals which indicate the presence of the selected characteristic waveform feature in each of the received plurality of first signals;

signal position estimation means operatively connected to the zero-crossing detection means and the processor means for estimating a position of the selected characteristic waveform feature of the plurality of received first signals in accordance with predetermined estimation criteria based on the detected zero-crossings to provide a position estimation value;

wherein the processor means processes the position estimation value to determine a corresponding estimation time and calculates the time of arrival of the selected characteristic waveform feature of at least one of the plurality of received first signals by adding a predetermined delay time to the estimation time.

25. The apparatus of claim 24 wherein said signal position estimation means comprises a dual slope integrator.

26. The apparatus of claim 24 wherein said plurality of received first signals are digitised and said processor means comprises digital data processing means comprising said zero-crossing detection means and said signal position estimation means.

27. A method of monitoring flow through a particle detector of an aspirated smoke detector system, the method comprising the steps of:

ascertaining the base flow of fluid through a particle detector using a flow sensor;

monitoring subsequent flow through the particle detector;

comparing the subsequent flow with the base flow, and indicating a fault if the difference between the base flow and the subsequent flow exceeds a predetermined threshold wherein base flow and subsequent flow are determined at respective times according to the following general flow calculation:

$$f = s \times A$$

where f = volumetric flow;

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)$$

where t_1 is the transit time of a signal transmitted in a forward direction, being generally in the direction of flow, from a first transducer located adjacent the flow path to a second transducer located generally opposite the first transducer and adjacent the flow path;

t_2 is the transit time of a signal transmitted in a reverse direction, being generally against the direction of flow, from the second transducer to the first transducer;

d is a distance travelled by the signal between the first and second transducer;

and wherein both t_1 and t_2 are determined in accordance with the method of any one of claims 1 to 12, 14 to 19 and 21 to 23.

28. Apparatus adapted to monitor flow through a particle detector of an aspirated smoke detector system, said apparatus comprising:

processor means adapted to operate in accordance with a predetermined instruction set,

said apparatus, in conjunction with said instruction set, being adapted to perform the method of claim 27.

29. A method of detecting one or more blocked sampling holes in a pipe of an aspirated smoke detector system comprising:

ascertaining the base flow of fluid through a particle detector using a flow sensor;

monitoring subsequent flow through the particle detector;

comparing the subsequent flow with the base flow, and indicating a fault if the difference between the base flow and the subsequent flow exceeds a predetermined threshold.

30. The method of claim 29 wherein the flow sensor is an ultrasonic flow sensor.

31. The method of claim 29 or 30 wherein the flow sensor comprises the apparatus of any one of claims 13, 20, 24, 25, 26 or 28.

32. The method of claim 29, 30 or 31 wherein the difference between base flow and subsequent flow is compared over a length of time.

33. The method of any one of claims 29 to 32 wherein the flow is determined according to the following general flow calculation:

$f = s \times A$

where f = volumetric flow;

A = cross sectional area of an air flow path through the detector system;

s = speed of air through the detector system such that s is given by;

$$s = \frac{d}{2}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)$$

where t_1 is the transit time of a signal transmitted in a forward direction, being generally in the direction of flow, from a first transducer located adjacent the flow path to a second transducer located generally opposite the first transducer and adjacent the flow path;

t_2 is the transit time of a signal transmitted in a reverse direction, being generally against the direction of flow, from the second transducer to the first transducer;

d is a distance travelled by the signal between the first and second transducer;

and wherein both t_1 and t_2 are determined in accordance with the method of any one of claims 1 to 12, 14 to 19 and 21 to 23.

34. An aspirated smoke detector comprising a particle detector, a sampling network and an aspirator, an inlet, an outlet and a flow sensor, wherein the flow sensor uses ultrasonic waves to detect the flow rate of air entering the particle detector.

35. The detector of claim 34 wherein the flow sensor measures the partial flow of fluid through a sampling network.

36. The smoke detector of claims 34 or 35 wherein the particle detector detects particles in a portion of the air flow flowing through the sampling network.

37. The smoke detector of any one of claims 34, 35 or 36 wherein the flow sensor is located in the sampling network.

38. The smoke detector of any one of claims 34, 35 or 36 wherein the flow sensor is located in a housing for the particle detector.

39. The smoke detector of any one of claims 34, 35 or 36 having a branch in the inlet allowing air to bypass the particle detector.

40. The smoke detector of any one of claims 34 to 39 wherein the flow sensor comprises the apparatus of any one of claims 13, 20, 24, 25, 26 or 28.

41. A computer program product comprising:

a computer usable medium having computer readable program code and computer readable system code embodied on said medium for determining the time of flight of a signal transmitted between a transmitter and a receiver within a data processing system, said computer program product comprising:

computer readable code within said computer usable medium for performing the method steps of any one of claims 1 to 12, 14 to 19 and 21 to 23.

42. A computer program product comprising:

a computer usable medium having computer readable program code and computer readable system code embodied on said medium for monitoring flow through a particle detector of an aspirated smoke detector system within a data processing system, said computer program product comprising:

computer readable code within said computer usable medium for performing the method steps of claim 27.

43. A computer program product comprising:

a computer usable medium having computer readable program code and computer readable system code embodied on said medium for detecting one or more blocked sampling holes in a pipe of an aspirated smoke detector system within a data processing system, said computer program product comprising:

computer readable code within said computer usable medium for performing the method steps of any one of claims 29 to 33.

44. A method substantially as herein described with reference to at least one of the accompanying drawings.

45. Apparatus substantially as herein described with reference to at least one of the accompanying drawings.